

March 2014

Hyperloop

Demonstrating technical feasibility.



What needs to be proven?

Validation

- Passenger Acceptability
- Operating Speed
- Re-pressurization / Stopping / Egress
- Tube Precision
- Station Operation

Passenger Acceptability

- ❖ Psychological Factors
 - ❖ Claustrophobia
 - ❖ Isolation
- ❖ Physiological Factors
 - ❖ Accelerations
 - ❖ Noise, Vibration & Harshness

These factors cannot be accurately addressed with a sub-scale model.

Operating Speed

- ❖ Critical Issues
 - ❖ Kantrowitz Limit with Compressor Flow Bypass
 - ❖ Gas Bearing Skis - Loading / Stability / Curves / Bumps
 - ❖ Compression-Lift - Performance / Cooling / Envelope
 - ❖ Attitude Control (e.g. engaging linear motor at 1220 kph...)

*These issues can be addressed with a sub-scale model, but different compressors may needed for full scale system. To achieve combination of speed and “g” load
Tube can be smaller diameter, but turn radius still large.*

Re-pressurization / Stopping / Egress

- ❖ Critical Issues

- ❖ Adiabatic Heating / Hotspots (during re-pressurization)
- ❖ Time to Safe Pressure (explosive Capsule decompression survivable?)
- ❖ Capsule Stability During Re-pressurization (at speed)
- ❖ Removal of stopped Capsules from Tube
- ❖ Egress / Recovery of Passengers from Capsule Stuck in Tube

These issues cannot be addressed with a sub-scale model.

Tube Precision

- ❖ Critical Issues
 - ❖ Manufacture of Tube Segments to Sub-millimeter Precision
 - ❖ Installation
 - ❖ Dimensional Stability - Capsule Dynamic Loads / Wind / Temperature
 - ❖ Pump-Down / Leakage

These issues cannot be accurately addressed with a sub-scale model.

Station Operation

- ❖ Critical Issues
 - ❖ Airlock Cycle Time
 - ❖ Passenger Loading / Unloading (including congestion mitigation)
 - ❖ Capsule Reversing Method (i.e. reversing capsule direction for return trip)

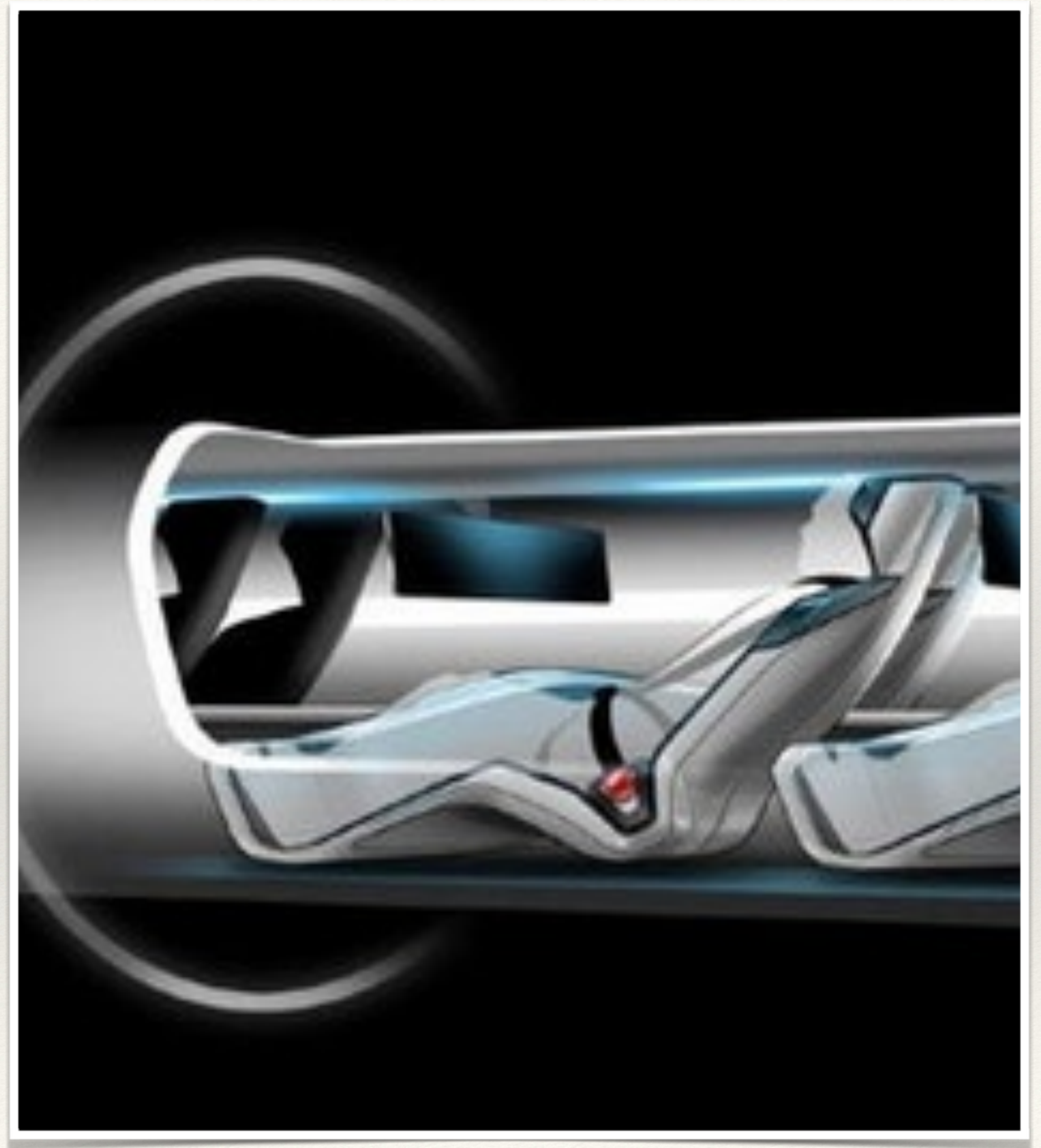
These issues cannot be convincingly addressed with a sub-scale model.

Full scale prototype is required to demonstrate critical elements.

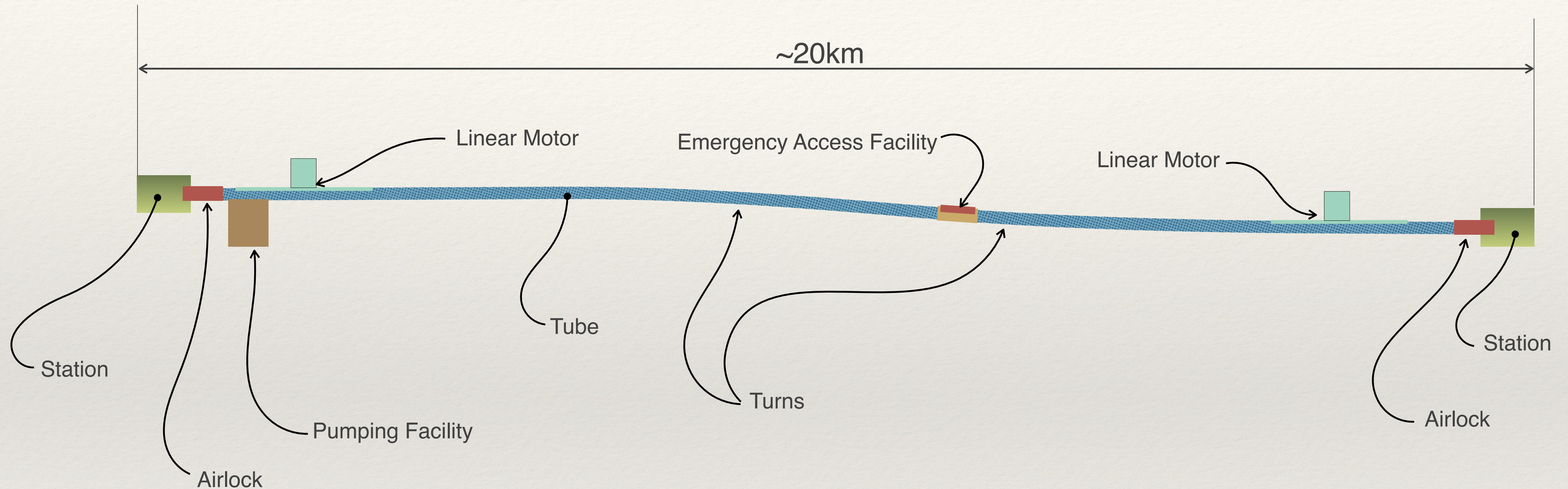
Full Scale

A sub-scale demonstrator cannot realistically validate critical aspects of Hyperloop.

Of the five critical aspects of Hyperloop that need to be validated, only operating speed can be demonstrated with sub-scale hardware, and even then the test system will be very large because turn radius cannot be reduced while maintaining both operating speed and “g” loading.



Hyperloop Validation



Full Scale Hyperloop Validation Prototype

The validation facility will be located along the proposed route and eventually be incorporated into the operational Hyperloop.

Features

- ❖ Full-Scale, Man-Rated Model - Can test with real people inside.
- ❖ Turns for ~1g radial acceleration at 1220 kph (~12 km radius)
- ❖ Estimated Cost \$275 million
 - ❖ Tube (incl. wiring, communications, re-pressurization) Pylons, Right of Way: \$100M
 - ❖ Airlocks, Access Facility, Pumping Facility, Stations, Controls: \$25M
 - ❖ Site Work, Utilities, Erection, Checkout: \$20M
 - ❖ Prototype Capsules (incl. component development): \$100M
 - ❖ Testing Operations: \$30M